Casting Design Rules for Reducing Porosity Defects

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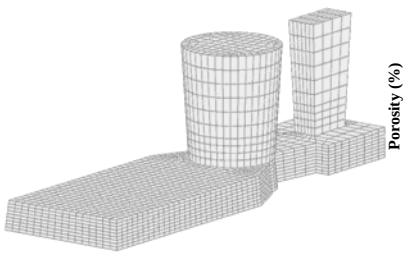
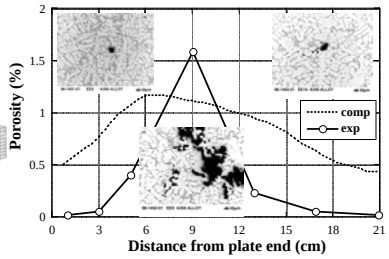
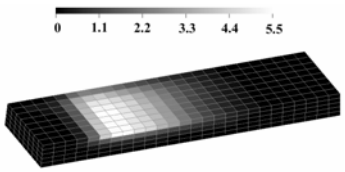


Casting



Porosity levels and defect morphology



Indicator of severity of microporosity defects

Past accomplishments: The porosity shape (2-nd picture) was correctly predicted by the computational methodology developed (3-rd picture shows predicted shape irregularity indicator).

Description An important factor that leads to a decrease in the mechanical properties of castings is the presence of microporosity. Interdendritic cavity defects, such as hot tears and shrinkage microporosity, are particular cases of feeding deficiencies that inherently take place during casting. A comprehensive model for predicting porosity distributions in complex shaped aluminum alloy castings was developed at ORNL. The computational methodology is general applicable to other alloys.

Unlike any other available, the ORNL microprosity methodology is able to predict accurately the location of "shrinkage" microporosity, which is of irregular and interdendritic shape that are more prone to crack propagation than "hydrogen" microporosity defects, which have well rounded shapes.

Benefits ORNL microporosity algorithm allows the prediction of the location and severity of interdendritic cavity defects. The design of casting processes will greatly benefit from the use of the ORNL software toolbox, which will enable the dimensioning and placement of the sprue, gating, and runner for reduce the severity of defects in castings, while increasing the production yield and energy savings.

The cost savings due to the introduction of this technology will come from the increased yield and the elimination of trial and error in the casting design process. This will lead to reduced material and energy needs, and economic benefits. The tools developed will also considerably improve overall productivity and expand markets,

The wide application of this software technology will specifically result in the following benefits:

- Energy efficiency through scrap reduction and yield increase;
- Pour molten metal at lower temperatures, resulting from process analysis.
- Reduced downtime due to mold rework; Furnace idling; Lost furnace heat. Die rework, and ensuing downtime will be eliminated.
- Less metal: Thinner walls, More structural geometry, less mass, resulting from through process analysis
- Productivity improvements; Less cutting, grinding, rework, heat treat, (More parts with have less defects and less part features will need machining)

Technology dissemination Some features of the microporosity algorithm were already implemented in the commercial casting software, ProCAST™. Constitutive model developments will be presented to other software vendors for the numerical simulation of fluid flow, heat transfer, and solidification during casting. Finally, the solution algorithms and details of the implementation methodology will be provided. Tutorials will be presented to foundries. Information will also be provided on permeability data and thermophysical properties needed for the numerical simulation other alloy castings than aluminum.